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A red squirrel's nest is key to winter survival

by Sarah Locke

Somewhere, in a tree near you, a red squirrel is trying to survive the Yukon winter. It might be tempting to take such a feat for granted as red squirrels are the most widespread and familiar mammals in the northern boreal forest, but these small bundles of energy are actually beating the odds.

"Red squirrels are the smallest mammals that stay active above the snow through a Yukon winter," says Murray Humphries, an assistant professor of wildlife biology at McGill University, "so it is always a question of how do they produce enough heat and conserve enough heat to survive when it is very cold outside."

When temperatures plummet, being big is a bonus. Large animals have less surface area compared to their total size than small ones, so big animals like moose and caribou can be complacent about temperatures that will send a tiny red squirrel running for cover.

The average red squirrel weighs only about 225 grams, and retreats to its nest when it is cold. The northern woods can seem uncharacteristically quiet during cold snaps when squirrels are not out and about, chattering and scolding and constantly telegraphing their presence.

Studying red squirrels in the Kluane area, researchers have learned that these tiny mammals have surprisingly low metabolic rates in winter. (photo: Sebastien Descamps)

Biologists had assumed that squirrels must fire up their internal furnaces in winter, generating their own heat, since their nests are up in trees, not under the insulating protection of the snow.

Small mammals such as voles and mice live in what is known as the subnivean space in the snowpack, down near the ground where temperatures are more moderate. (While this strategy works well in a typical year, no doubt these mammals are suffering mightily this year because of the lack of snow.)

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"A physiologist would expect that a red squirrel would have an extremely high metabolic rate in winter," says Humphries, who has worked on squirrels and other small mammals in the Kluane area for the past 12 years.

"Curiously enough, the colder it is, the lower the rate of their energy expenditure. Relative to their body size, red squirrels expend less energy during a Yukon winter than humans or even sloths. They have the metabolic rate that one would expect of an animal at 23 °C."

"The trick is that red squirrels do not come out of their nests much on cold days."

In January and February, 2002, Humphries and some of his graduate students trapped red squirrels in the Kluane area to determine how they use energy in winter. Using a technique known as "doubly labelled water," they were able to measure the field metabolic rate of the squirrels, which indicates how much energy the animals are expending.

They expected to find that the squirrels' metabolic rate went up as the temperature went down, a response that has been documented in hundreds of other animals. To their surprise, the researchers found that red squirrels have different means for coping with the cold.

Humphries says that with hindsight, it is obvious that the squirrels survive winter by spending more time in their nests, but they now appreciate that a squirrel's home must be much cozier than they had ever dreamed.

Round spheres made of grass, the nests are lined with shredded bark. Kluane researches have also noticed that the nests usually face south, thus maximizing warmth from the sun.

A squirrel builds its nest in a tree above its midden, the combination pantry and garbage pile which is the centre of a squirrel's small universe. This is where it buries the spruce cones on which it feeds all winter, and this is where the leftover bits of cones collect as the squirrel feeds in the branches overhead.

The researchers caught 61 female squirrels by baiting traps near their middens. After weighing the squirrels, they injected them with the doubly labelled water, which contains stable isotopes of hydrogen and oxygen. "It is totally harmless stuff; people can drink it," he says.

A blood sample is taken after the squirrels have spent another hour in the traps, allowing time for the injected water to equilibrate with the water in their bodies. Then they are released so that they can run around and do the normal things squirrels do, excreting water and feces and exhaling carbon dioxide, all of which lead to a decline in levels of the oxygen isotope.

Luckily squirrels are easy to trap, and a dollop of peanut butter allowed them to be recaptured a few days later. Another blood sample was taken, and the change in

isotope levels between the two samples was used to calculate the squirrels' metabolic rates.

These metabolic rates proved to be among the lowest ever recorded in warm-blooded animals. But then again, very little work has been done on winter metabolism in the North; in fact, only one other field study has been conducted when temperatures were in the -20 °C range.

Humphries is keen to learn more about the metabolic rates of animals in winter. In future winters, he plans to return to the Yukon with a mobile field laboratory. Working out of a specially designed 11-metre trailer, he and his graduate students will be able to trap small mammals and measure their resting metabolic rates, which he describes as an animal's "idling speed."

"We want to get out in winter as it is the most interesting time to look at energetics, and it is remarkable how little we know about what happens then," says Humphries. "With the lab, we can look at how animals change morphologically and physiologically in winter."

A report on this work was recently published in the journal *Ecology Letters*. For more information, contact Dr. Murray Humphries at murray.humphries@mcgill.ca.